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April 1977 Working Paper No. 918-77

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There are at least three general strategies which an R&D organization can employ to keep abreast of relevant technological developments. First, to the extent that it is growing or enjoys a regular turnover of personnel, it can attempt to hire new employees who are acquainted with recent developments the relevant technologies. In other words, it imports new technological know-how by hiring those who possess it. Second, since some technological developments are well documented, it can invest in the means to provide its members with access to this documentation. Finally it can encourage or arrange for direct formal or informal personal contact between its members and those outsiders possessing the desired technological information.

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Direct Personal Contact Outside of the Organization

Turnover and inter-organizational movement of personnel is a topic which we have treated extensively elsewhere (Allen & Cooney, 1974). The documentation channel is also one which we shall defer. It too, has received considerable attention elsewhere.

The last of the three general strategies is the one to which we shall direct our attention, at this point. In our earliest research (Allen, 1964; 1966) it was shown that a consistent inverse relation existed between direct personal contact outside of one's organization and technical problem solving performance. Similar results have been reported by a number of other investigators concerned with communication in research and development. A very consistent inverse relation has been found between external communication and performance of engineers and scientists in industrial organizations. Basic research scientists in universities, on the other hand, have demonstrated a very strong direct relation between performance and communication with colleagues in their specialty outside of their university. An explanation for this difference lies in a subtle but major distinction between science and technology. Science can be said to be universal. Within a given specialty scientists are all working toward the same goals and operating within a common social system. A scientist is therefore fully capable of understanding the nature of the problem and approaches employed by other scientists in his specialty anywhere in the world. Technology, on the other hand, is not universal. It is highly localized. Technological problems are not defined in universal terms. They are defined in terms of the interests, goals and local culture of the organization, in which they are being attacked. Similar technological problems become defined in very dissimilar ways by the organizations working on them. Organizations differ in their definition of goals and in their value systems. They tend

to develop sub-cultures of their own. Technological problems are then defined within the value structure of this sub-culture. Certain types of solution, which may be perfectly acceptable in one organization, will simply not work when applied to the same problem in another organization. This is not usually apparent to an outsider. Consequently, it is very difficult to fully communicate the nature of a technological problem to a person outside of the organization. Both parties may think that the outsider understands the problem, but his understanding is usually incomplete and his proposed solutions are not likely to fully match the locally-defined solution space. As a result, the externally defined solutions perform less well, and we have the resulting inverse relation between external consultation and technical performance.

The Technological Gatekeeper and Communication Outside of the Organization

The apparent difficulty in communicating effectively across organizational boundaries, coupled with results that showed intra-organizational communication to be very strongly related to R&D performance (Allen, 1964; 1966; 1970; Baker, et.al., 1967; Goldhar, et.al., 1976) left the problem of transferring technology between organizations largely unresolved. Of course, there is always the contribution from turnover of technical staff. And this is an extremely important vehicle for technology transfer. Still it did not seem a sufficient explanation. There must be other channels as well. If the internal consultant is, as all the evidence would indicate, such an excellent source of technical information, where does he acquire his information?

The second phase of the research was directed to answering this question. What we wanted to do was to move one node back in the internal communication network and determine where the inputs to that point originated.

To accomplish this goal, a number of R&D laboratories were surveyed to

determine the communication patterns of their technical staffs. Communications were sampled over periods varying from three months to a year. Once a week, on randomly chosen days, questionnaires were distributed. Each questionnaire listed the names of all members of the organization's technical staff. Respondents were asked to look down the list and check off the names of those with whom they had discussed a technical or scientific topic, on that day. After these had been collected for several months, the average frequency of communication between pairs of individuals could be computed. Networks could then be created for any frequency of communication, showing for example which pairs communicated at an average of at least once a month (Figure 1).

The two approaches produce reasonably comparable results, with some slight increase in the correctedness of networks based on the second of the two approaches.

In the tradition of such (Lazarfeld, et.al., 1944; Katz & Lazarfeld, 1955; Katz, 1957; Coleman, et.al. 1966) high communicators, or stars, were first identified and then compared with their less communicative colleagues. The key dimension on which comparison was made was the degree of technical communication outside of the organization. The stars of the internal network were found to have a significantly higher degree of long term informal contact with colleagues outside of their organization and to have a significantly higher readership of the professional scientific and engineering literature (Allen, 1977; Allen & Cohen, 1969; Frost & Whitley, 1971; Taylor & Utterback, 1975).

Those internal stars who also maintained a very high degree of external communication were labelled "technological gatekeepers" (Allen & Cohen, 1969). They were found to have a number of interesting characteristics. For example, they were not merely high communicators. They were high technical performers as well. They were over-represented at the lower levels of the organizational hierarchy, and seldom found near the top. Finally, they were not formally

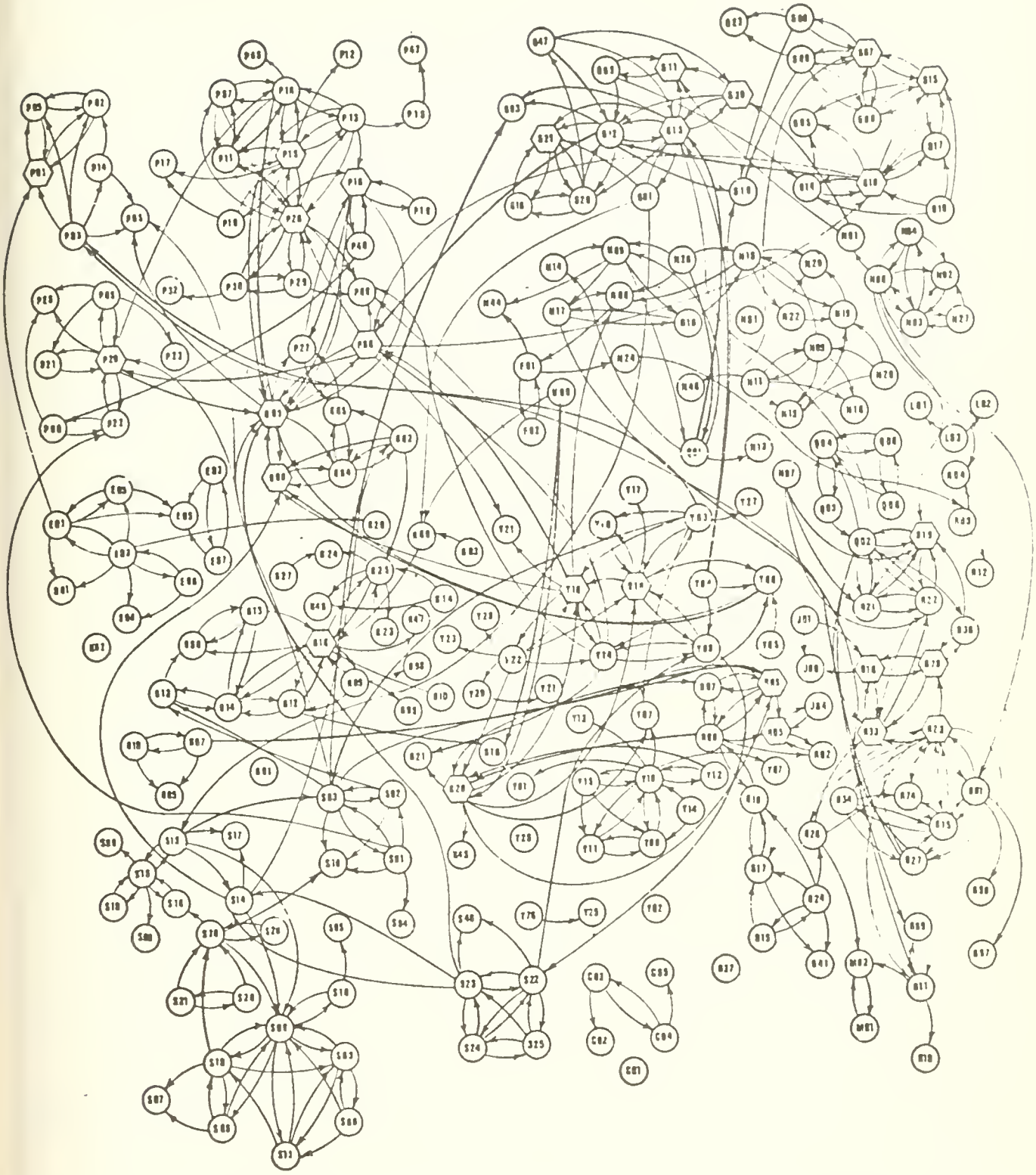

Figure 1. Communication Network of an R&D Laboratory. (Based on an Average Frequency of Communication of at Least Once Per Week.)

Note: Gatekeepers are represented as hexagons

(From Allen, 1977)

recognized by the organization but once the concept was described could usually be named quite accurately by the organization's members.

Research Method and Setting for the Present Study

The results summarized above once again can be seen very clearly in a study of communication in a large research and development organization, that is the principal focus of the present paper. The organization supported work ranging from fairly fundamental scientific investigations through product and process development to what is called technical service, or very applied technical problem - solving adapted to the needs of specific customers. There were a total of 345 professionals organized in 62 projects, performing this work.

Technical communications among the technical staff and between the staff and people outside of the organization were sampled for a period of 15 weeks, according to the method previously described. The overall rate of response for the 15 weeks was 93 percent. The level of reciprocation among communication partners (i.e., the extent to which both parties reported a given communication) was 68 percent.

Analyses in this paper will be performed at the level of the project. Projects were classified as falling into the research, development or technical service categories on the basis of the responses of participants, when asked to characterize the work of the project, according to the categories of Table I. An analysis of variance across projects showed a significant degree of agreement ($p=0.001$)in this classification.

Differences Across Project Type

Relating project performance to extra-orgnizational communication, we find a fairly strong positive relation for research projects, but a negative or inverse relation for development projects (Figure 2). The relation for technical

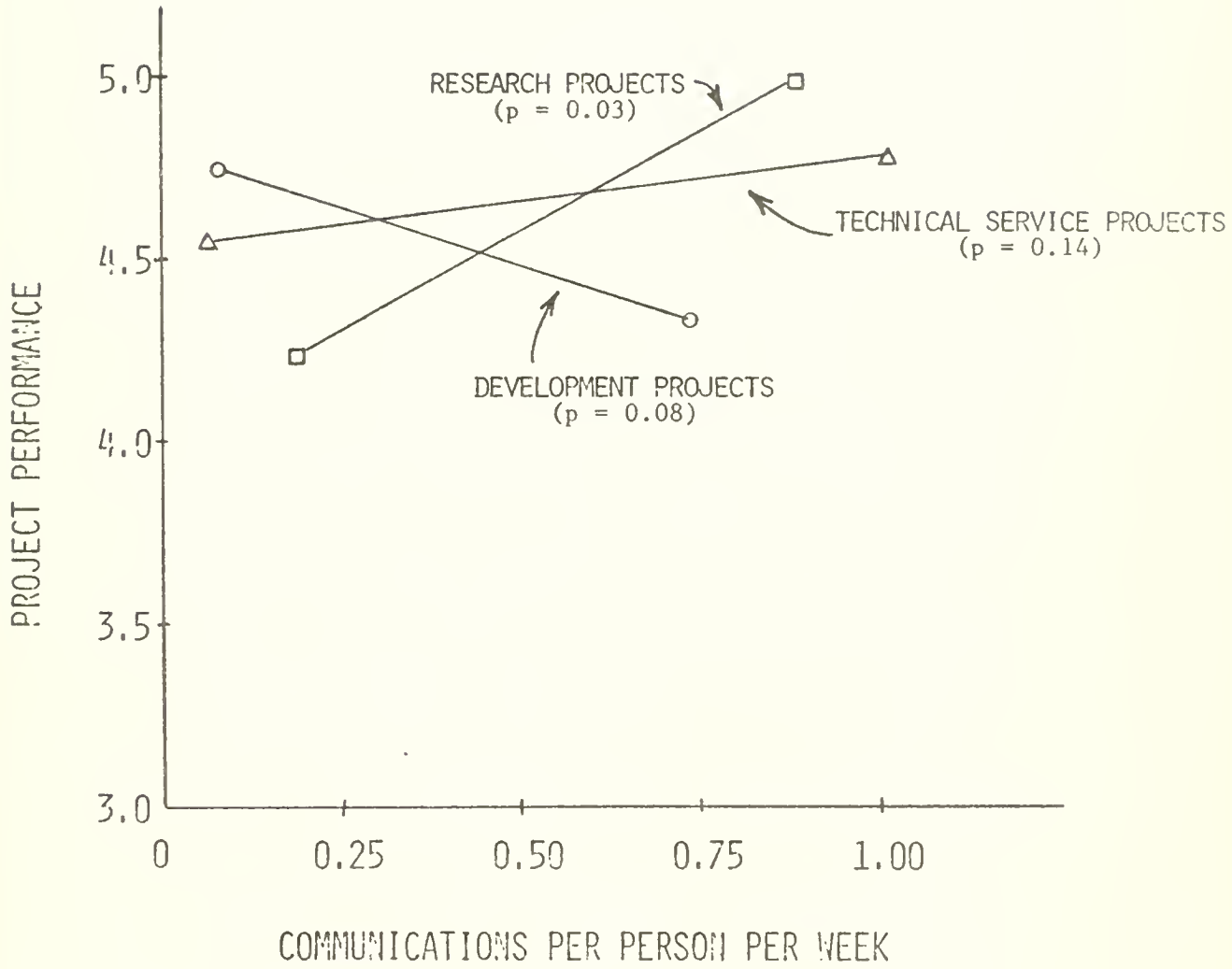

FIGURE 2. RELATIONSHIP BETWEEN PROJECT PERFORMANCE AND THE MEAN LEVEL OF PROFESSIONAL COMMUNICATION OUTSIDE THE ORGANIZATION.

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service projects is positive, but much weaker than that for research. In contrast, the variation in external communication across individual project

Table I

Definitions Used in Categorizing Projects

Category	Definition
Research	Work of a general nature intended to apply to a broad range of applications or to the development of new knowledge about an area. Work involving basic knowledge for the solution of a particular problem. The creation and evaluation of new concepts or components but not development of operational use.
Development	The combination of existing or feasible concepts, perhaps with new knowledge, to provide a distinctly new product or process. The application of known facts and theory to solve a particular problem through exploratory study, design and testing of new components or systems.
Technical Services	Cost/performance improvement to existing products, processes or systems. Recombination, modification and testing of systems using existing knowledge. Opening new markets for existing products.

members shows markedly different relations with performance (Figure 3). The degree to which members of research or technical source projects varied in their degree of external contact, bore very little relation to the performance of the project. On the other hand, the more those working on development projects varied in their external communication, the better the performance of the project.

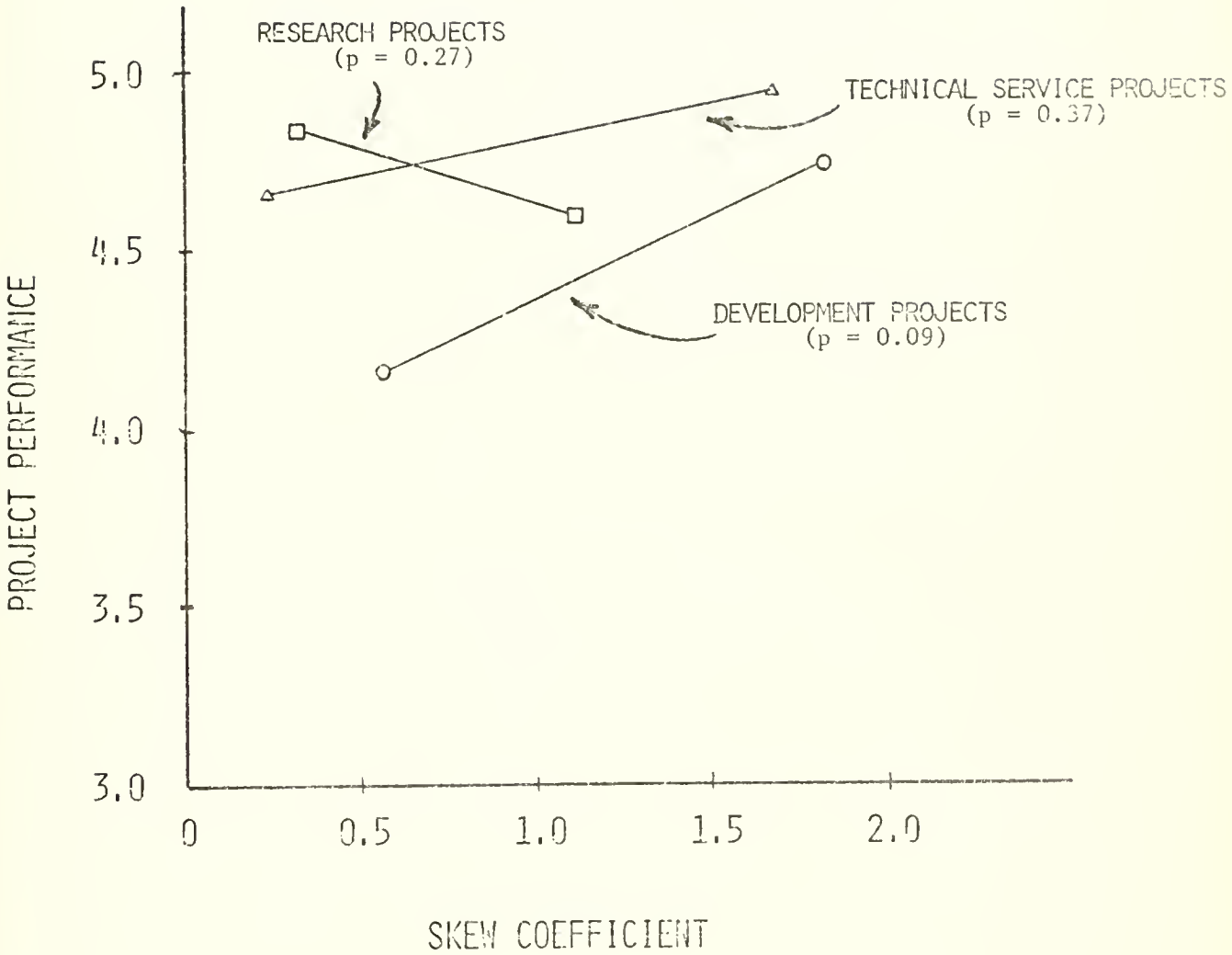

FIGURE 3. RELATIONSHIP BETWEEN PROJECT PERFORMANCE AND THE DEGREE TO WHICH THE DISTRIBUTION OF EXTERNAL PROFESSIONAL COMMUNICATION IS SKEWED ACROSS PROJECT MEMBERS.

In other words, when research scientists uniformly increase their communication with the world outside of their organization, they improve their chances of producing a higher quality solution. In contrast, when development technologists decrease their average level of external communication but at the same time allow a few of their number to maintain or increase their communication, their probability of better quality solutions is enhanced. The technologists are better off facing up to the parochial nature of technology and allowing only those individuals who are capable of functioning in and understanding both their own and other social systems to assume responsibility for external communication. This is the logic behind the gatekeeper concept first proposed by Allen and Cohen (1969). Because technological problems are defined in local terms, most technologists have difficulty in communicating effectively with outsiders about their problems. Fortunately, however, there often appear a few individuals who maintain consistent ongoing contact outside of their organizations, who understand the way in which outsiders differ in perspective from their organizational colleagues, and who are able to translate between the two systems. The gatekeeper is able to understand external technological developments and to translate these into terms that can be understood by and are relevant to his organizational colleagues. The gatekeeper performs an extremely important role in many organizations. He is the principal channel for effectively transferring technology into the organization.

Limitations on the Applicability of the Gatekeeper Concept

The preceding presentation, in addition to showing the importance of the gatekeeper role in organizations, also shows one area in which it is not important. These data and Hagstrom's (1965) earlier work indicate that basic research scientists have little need for the specialized role of the gatekeeper. In science, individuals are less constrained by local circumstances and are

able to communicate effectively with colleagues, who share their research interests, regardless of where those colleagues might be. So the gatekeeper is really the offspring of technology. The parochial nature of technology created the need for gatekeepers, and it is only organizations pursuing technology, that will benefit from this role. There is also some indication that the gatekeeper is of importance only when the technology is somewhat sophisticated. The results here are not as yet completely clear, but among the technical service projects there was little relation between project performance and either the mean level of external communication or the variation among individuals in external communication. There is some indication that in technical service projects, the administrative hierarchy assumes more of the responsibility for external communication. This is similar to the situations reported by Frost and Whitley (1971) where, in a laboratory providing consulting services in metallurgy, they found that first level supervisors provided the laboratory's principal connection to the world. The informal gatekeeper role, independent of the organizational hierarchy was somewhat less important in that laboratory. It may also relate to the results of Walsh and Baker (1972), where the gatekeeper role did not appear. In both of these studies, there is a strong possibility that the nature of the task approached that of technical service.

These results probably stem from the fact that the technologies employed by technical service projects are more established, less dynamic and even more closely coupled to organizational goals than are the technologies used in product or process development. The formal organization, through its hierarchy, provides the vast majority of information required by technologists performing this service function. The need for creativity, while not absent, is certainly less in technical service. The technologies, being less complex, are more easily dealt with and understood by the management of the organization. It is only when the technologies become more complex, in the development projects,

that the need arises for a specialized role, in which the individual is in close touch with the details of the work and conversant with developments in specific technologies required.

What all of this leads to is a situation in which the concept of gatekeeper is important to organizations only within certain limited circumstances. When the organization is a basic research laboratory, gatekeepers are unnecessary, because the organization itself does not impede communication with the outside world. At the other end of the R&D spectrum, when the organization is concerned chiefly with the application of well-established technologies to well-specified situations, there is little need for gatekeepers since the organization is capable of structuring itself to provide the technical information needed by its members. It is only in the middle range of the science to technology or research to development spectrum that gatekeepers assume their full importance. When the organization is concerned with innovation and is itself contributing to technological advance the gatekeeper provides the most effective link between the organization's efforts and those being pursued elsewhere.

Gatekeepers and Opinion Leaders

An important distinction should be made at this point between the gatekeeper concept and the concept of opinion leader which Katz (Katz, et.al., 1963), Rogers (Rogers and Shoemaker, 1971) and others have discussed. Gatekeepers and opinion leaders are similar in many ways, but differ along a number of critical dimensions. Perhaps the most important of these differences involves the type of social system in which they operate. Most studies of opinion leadership have been done inside of bureaucratic structures. They have dealt with farmers, physicians, consumers and others, who are generally not members of a common hierarchical organization. It is bureaucracy, with its control of reward systems and careers, and its emphasis on system boundaries that creates the barriers to com-

munication described in the initial paragraphs of this paper. The gatekeeper arose to fulfill a need with which bureaucracy was incapable of dealing. When bureaucratic organization is weak or absent, as in the case of research scientists, farmers, physicians, etc., there is little need for such boundary-spanning role, as the gatekeeper. The boundary is not so well-defined and communication is not seriously impeded. When technology is stable, formal mechanisms can be employed by the organization to bring technology to its users. Perhaps some form of opinion leadership may exist in this situation, with contact occurring among those at high levels in several organizations (Cr. Carlson, 1964). Internal diffusion is accomplished through the formal hierarchy of the organization. Bureaucracy is able to handle situations in which technologies are well-defined and stable, or when an innovation is already well-defined and packaged by the innovator or innovating organization.

It is when there exists a well-defined bureaucratic boundary and a dynamic technology, that the gatekeeper is important. The well-defined boundary, with its impedance to communication requires some boundary-spanning mechanism. The dynamic technology implies a need for someone, who is intimately conversant with it to play the role of introducing it to the organization. Of course, to be intimately conversant with a dynamic technology one must almost necessarily be contributing to it in a direct way, himself. Such direct technological contributors are seldom found in the higher levels of organizations. Therefore, it must be someone who is at or near the bottom of the organization, who accomplishes this feat. In other words, the organizational hierarchy is by-passed by informal relations developed by the gatekeeper with his colleagues outside of the organization. Information is then diffused within the organization, through informal contact, which is also independent of the hierarchy.

This is the only way in which a dynamic technology can be continuously drawn into the organization. But it is an avenue that is only necessary when the conditions of bureaucratic organization and dynamic technology co-exist simultaneously.

An important corollary, that can be derived from the above is that only organizations which are themselves supporting work in more dynamic technologies can hope to keep abreast of these technologies.

Gatekeepers, in the strictest sense of the term will be useful only in organizations, which are themselves contributing to the development of technology. In other organizations, opinion leaders at higher levels of the bureaucratic hierarchy must be relied on to provide access to information about innovations, and this information can be disseminated formally within the organization. The distinction is one of organizational level and degree of formality in the internal dissemination process. The gatekeeper functions at the lowest levels in an organization and relies entirely on informal processes for dissemination. The opinion leader operates at much higher levels in the organization and is able to utilize more formal dissemination techniques.

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